ANALYSIS

30(132), April 1, 2015

ISSN 2278–5469 EISSN 2278–5450

Discovery

Performance analysis of vertical handover triggering algorithms for data over cellular network

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Publication History
Received: 13 February 2015
Accepted: 17 March 2015
Published: 1 April 2015

Citation
Agalya S, Prabaharan G. Performance Analysis of Vertical Handover Triggering Algorithms for Data over Cellular Network. *Discovery*, 2015, 30(132), 302-309

ABSTRACT

For real-time applications running over hand-held mobile terminals in heterogeneous environments, efficient vertical handover (VH) algorithms are required in maintaining a seamless connectivity and an acceptable level of quality. While received signal strength-based methods have dominated this class of algorithms, we propose a thorough system analysis framework and perform rigorous analysis for packet-loss based algorithms for an interworking environment comprising the cellular network and the Wireless Local Area Network (WWSN). This paper proposes a novel vertical handoff algorithm between WWSN and CDMA networks to enable the integration of these networks. The proposed vertical handoff algorithm assumes a handoff decision process (handoff triggering and network selection). The handoff trigger is decided based on the received signal strength (RSS). To reduce the likelihood of unnecessary false handoffs, the distance criterion is also considered. As a network selection mechanism, based on the wireless channel assignment algorithm, this paper proposes a context-based network selection algorithm and the corresponding communication algorithms between WWSN and CDMA networks. The OQAM (Orthogonal Quadrature Amplitude Modulation) modulation and demodulation reduces the bit error rate as well as increase the signal strength at the nodes of the networks. This model is applicable to different networks which all are connected by the multiple Nodes. In this project, various positioning

algorithms for range-based Time of Arrival (TOA) and Time Difference of Arrival (TDOA) localization based on the dual clustering protocol have been analyzed.

1. INTRODUCTION

A Wireless Sensor Network (WSN) can be defined as a network of devices, denoted as nodes, which can sense the environment and communicate the information gathered from the monitored field (e.g., an area or volume) through wireless links. The data is forwarded, possibly via multiple hops, to a sink (sometimes denoted as controller or monitor) that can use it locally or is connected to other networks (e.g., the Internet) through a gateway. The development of wireless sensor networks was motivated by military applications such as battlefield surveillance; today such networks are used in many industrial and consumer applications, such as industrial process monitoring and control, machine health monitoring, and so on. a group of sensor nodes collect information from a target region. When the base station queries the network, the data of each sensor node are not required to be sent to the base station. Instead, one of the sensor nodes called the aggregation node, collects the information from its neighbouring nodes, aggregate the information (e.g., compute the sum, average, minimum or maximum)and then send the aggregated data to the base station.

The potential of WSN systems is nothing short of revolutionary. This technology will affect all aspects of our lives. Substantial improvements in agriculture, industrial automation, transportation, energy, medicine, and the military are occurring and will accelerate in the near future. Since the scope of WSNs is so vast, there are many variations in the hardware/software solution space of WSN technology. A simplified generic view of the hardware/ software helps develop a basic understanding of how these systems work. . A sensor node might vary in size from that of a shoebox down to the size of a grain of dust, although functioning "motes" of genuine microscopic dimensions have yet to be created. The cost of sensor nodes is similarly variable, ranging from a few to hundreds of dollars, depending on the complexity of the individual sensor nodes.

2. RELATED WORKS

A. Reinforcement learning algorithm

Reinforcement learning algorithms for dynamic evolutionary game-based network selection [1]. in the reinforcement-learning-based algorithm, the users learn the performances and prices of different networks by interaction. Knowledge gained from learning is used to make the best decision for network selection.

B. Network selection algorithm

Network selection algorithm [2] is designed to guide user's behaviour in cooperative ways, and used the parameter of user preference to reduce network congestion and the ping-pong effect during handoff process. User terminal selects the most efficient network according to RSS, resource price and user preference.

Detect RSS.
For y = 1: Y
Detect the RSS of network y in a gliding window with
length t,;
Calculate the average value of RSS(y);
If(RSS(y) > T(y))
Network y become candidate network, add it to set x;
End
End

C. Vertical handoff decision algorithms

Vertical handoff decision algorithms have been developed to maximize the benefit of the handoff for both the user and the network. The optimizations incorporate a network elimination feature, to reduce the delay and processing required in the evaluation of the cost function, and a multi-network optimization [3] is introduced to improve throughput for mobile terminals with multiple active sessions.

D. Handover triggering algorithm

A generic handover algorithm relies on the observed RSSI samples in deciding whether and when to initiate a Handover. Some derivative of the RSSI samples is used in assessing the condition of the WLAN interface. When an MT is connected to the WLAN, it triggers a handover from WLAN to cellular (the “hand-out” operation) if the predefined RSSI derivative meets a certain condition. For example, the algorithm in triggers a hand-out if a certain number of consecutive RSSI samples fall below a given threshold. In heterogeneous wireless networks, a mobile node receives various signal strengths from different networks.

E. Relay selection

Combine the network coding and relay selection to improve the transmission efficiency and system performance in two-way relay channels. We proposed several selection schemes that optimize the overall performance of two users, including single relay selection with NC (S-RS-NC) and dual relay selection with

NC (D-RS-NC). To simplify the relay selection process, we propose several simplified selection criteria.

3. SYSTEM ARCHITECTURE

The architecture involves the processing of data aggregation in the sensor environment. The sender wants to send the request query to intermediate nodes in order to collect the information from the sensor nodes.

Architecture model

The WSN are tremendously being used in different environments to perform various monitoring tasks such as search, rescue, disaster relief, target tracking and a number of tasks in smart environments. In many such tasks, node localization is inherently one of the system parameters. Node localization is required to report the origin of events, assist group querying of sensors, routing and to answer questions on the network coverage. So, one of the fundamental challenges in wireless sensor network is node localization.

The time delay calculation and time difference between nodes are to be calculated. TDOA and TOA based localization methods require sensor synchronization. When nodes are spatially separated and connected by a wireless network, achieving precise synchronization is a challenging task. In general synchronization algorithms require a heavy signalling payload in the network, which implies a significant energy consumption at each node and a consequent reduction in node lifetime.

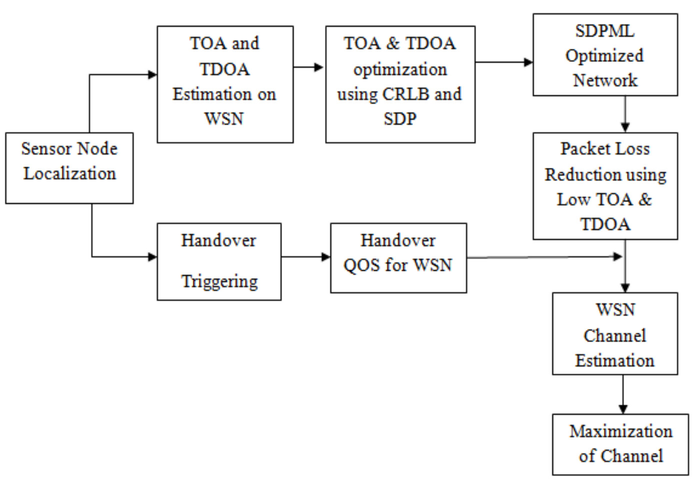

Figure 1 Packet loss minimization architecture diagram

4. SYSTEM MODULES

A. Node Localization

A typical WSN consists of a large number of sensor nodes, because the transmission range of each sensor node is limited and the field in that they are deployed covers a large area. It include the active nodes and passive nodes. Active node contains more energy than passive nodes. So separately grouping the active nodes and passive nodes through K-means clustering. Least square method detect whether the node is active or passive. "Least squares" means that the overall solution minimizes the sum of the squares of the errors made in the results of every single equation

B. Estimating ToA & TDoA

Calculate the Time of Arrival and Time difference of Arrival through SDP algorithm. The propagation time can be directly translated into distance, based on the known signal propagation speed. These methods can be applied to many different signals, such as RF, acoustic, infrared and ultrasound. TDoA methods are impressively accurate under line-of-sight conditions. But this line-of-sight condition is difficult to meet in some environments. Furthermore, the speed of sound in air varies with air temperature and humidity, which introduce inaccuracy into distance estimation. Acoustic signals also show multi-path propagation effects that may impact the accuracy of signal detection.

ToA : Travel time of data from a single transmitter to a remote single receiver.

TDoA : Time taken to travel data from one sensor node to neighbour sensor node .

C. Reduce Instantaneous Packet Loss

Since WSN have a large coverage area, it must contain the packet loss. Even though it has a multipath propagation, it doesn't deliver the exact data which is given by the source. So packet loss has been occur. Data's in WSN are generally in terms of bits, but our propose is to reduce the packet loss. Convert the bits into packets has been done through the following,

Packets=bits/symbols

After this conversion send packets to sink through WSN. Packets are in array format, this have to convert as matrix format by applying Inverse Fast Fourier Transform (IFFT). Minimize or reduce the packet loss by using circular prefix. This can be applied through circular buffering.

D. Improve Channel Gain and Signal Strength

Create a network with orthogonality i.e each and every sensor node in the network can move along 360 degree. When transmit data in free space, it must generate the unpredictable noise. Using SDPML algorithm give these noise to the two different channel. And also using MRC (Maximum Ratio Combining) to minimize the noise and reduce the errors.

5. METHODOLOGY

A. Semi Definite Programming algorithm

Finding the positions of nodes in an ad hoc wireless sensor network (WSN) with the use of the incomplete and noisy distance measurements between nodes as well as anchor

position information is currently an important and challenging research topic. In this work, Semi-Definite Programming (SDP) algorithms are devised for node localization in the presence of these uncertainties. We propose an algorithm to locate a node with unknown coordinates based on the positive semi-definite programming in the wireless sensor networks, assuming that the squared error of the measured distance follows Gaussian distribution. We first obtain the estimator of the object location; then transform the non-convex problem to convex one by the positive semi-definite relaxation; and finally we take the optimal solution as the estimated location.

TOA BASED LOCATION ESTIMATION

The position of the target node is determined as the intersection of all the spheres, of which centers are the coordinates of the reference nodes and radiuses are the ranges between the reference nodes and the target node. The spheres can be described as below, $(x-x_i)^2+(y-y_i)^2+(z-z_i)^2=m_i^2$ Where i=(1,2,.........n) where (xi, yi, zi) and mi (i=1,2,...,n) are the known coordinates of the reference nodes and the range estimations respectively. n is the number of reference nodes. The coordinates of the target node to be estimated are referred to as (x, y, z). The accuracy of range estimation is affected by noise and the multipath components, thus the spheres will not always intersect at one single point. The goal of the location estimation is to find out the closest coordinates to the actual position.

DATA MODULATION USING QAM

Frequency-shift keying FSK is a form of constant-amplitude angle modulation similar to standard frequency modulation (FM) except the modulating signal is a binary signal that varies between two discrete voltage levels rather than a continuously changing analog waveform. Consequently, FSK is sometimes called binary FSK (BFSK).

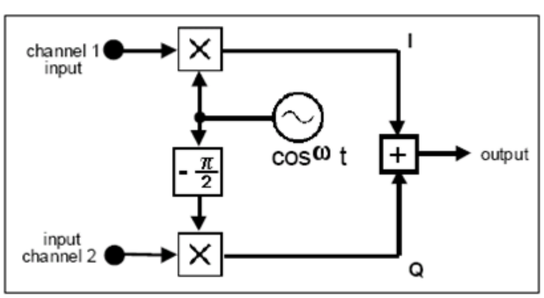

Figure 2 Quadrature modulation

Figure 2 shows a block diagram of quadrature amplitude modulation. It does not contain any band limiting. In a practical situation this would be implemented either at message level - at the input to each multiplier - and/or at the output of the adder. The motivation for QAM (Quadrature Amplitude Modulation) comes from the fact that a DSBSC (Double Side Band Sub Carrier) signal occupies twice the bandwidth of the message from which it is derived. This is considered wasteful of resources. QAM restores the balance by placing two independent DSBSC, derived from message #1 and message #2, in the same spectrum space as one DSBSC. The bandwidth imbalance is removed. In digital communications this arrangement is popular. It is used because of its bandwidth conserving (and other) properties. It is not used for multiplexing two independent messages. Given an input binary sequence (message) at the rate of n bit/s, two sequences may be obtained by splitting the bit stream into two paths, each of n/2 bit/s. This is akin to a serial-to-parallel conversion. The two streams become the channel 1 and channel 2 messages of Figure 1. Because of the halved rate the bits in the I and Q paths are stretched to twice the input sequence bit clock period. The two messages are recombined at the receiver, which uses a QAM-type demodulator.

B. Cramer Rao Lower Bound algorithm

To improve the ranging quality the CRLB can be improved, we design two local filtration techniques, namely neighbourhood hop-count matching and neighbourhood sequence matching, to find nodes with better location accuracy. The filtered good nodes can be used to improve the location accuracy of neighbouring nodes. Using the good nodes to calibrate the bad ones, we employ the weighted robust estimation to emphasize contributions of the best range measurements, eliminate the interfering outliers, and suppress the impact of ranges in between.

CRLB AND MAXIMUM LIKELIHOOD ESTIMATION (MLE)

The CRLB determines a lower bound on the performance (variance) of any unbiased estimator. The CRLB of the unknown parameters $\theta=\left[x^T d_0\right]^T$

$$I(\theta)=F(\theta)^T WF(\theta) \qquad (1)$$

Where,

$$W=\mathrm{dia}\left\{\sigma_1^{-2},\sigma_2^{-2},\ldots\ldots\sigma_M^{-2}\right\}$$

The CRLB of the unknown parameter θ is computed as

$$\mathrm{Var}\left([\theta]_r\right)\geq\left[I^{-1}(\theta)\right]_{r,r} \qquad (2)$$

When the number of measurements tends to infinity, the ML estimator can achieve the CRLB. In other words, the ML estimator is asymptotically optimal. The ML estimator of the

measurement model in is obtained by the following optimization problem.

$$\hat{\theta} = \arg\min \sum_{i=1}^{M} \sigma_i^{-2} (r_i - d_i - d_0)^2 \quad (3)$$

The derivation of the proposed SDP approach is described as follows

First, the nonlinear cost function of the ML estimator is converted into a convex cost function and then is formulated as a SDP optimization problem. Unlike the ML estimator, the proposed SDP technique neither requires initialization nor has convergence problems.

The cost function of the ML estimator in (3) can be alternatively written as

$$(r - d - d_0)^T W (r - d - d_0) =$$
$$\mathrm{Trace}\left\{W\left(r - (d + d_0)\right)\left(r - (d + d_0)\right)^T\right\} \quad (4)$$

Where $d = [d_1, d_2, d_M]^T$ $d_0 = [d_0, d_0, ...d_0]^T$

defining a new vector as $h = [d_{1,} d_2, ...d_M, d_0]^T$

we can write $d + d_0 = Uh$ (5)

$$U = [I_M, 1_M]$$

Plugging 5 in 4 yields

$$\mathrm{Trace}\left\{W(r - Uh)(r - Uh)^T\right\} =$$
$$\mathrm{Trace}\left\{W\left(rr^T - 2Uhr^T + UHU^T\right)\right\} \quad (6)$$

Where $H = hh^T$ .The diagonal elements of matrix H are,

$$[H]_{ii} = d_i^2 = \begin{bmatrix} y_i \\ -1 \end{bmatrix}^T \begin{bmatrix} I_2 & x \\ x^T & z \end{bmatrix} \begin{bmatrix} y_i \\ -1 \end{bmatrix} \qquad i=1,2,....,M.$$

(7)

where $z = x^T x$ .To convert the non-convex cost function in (6) into a convex function, we have to relax non-affine operations. By relaxing the matrix H and the variable z, they can be written as a linear matrix inequality (LMI) using Schur complement.

$$z = x^T x \Rightarrow \begin{bmatrix} I_2 & x \\ x^T & z \end{bmatrix} \succ 0_{3,}$$

$$H = hh^T \Rightarrow \begin{bmatrix} H & h \\ h^T & 1 \end{bmatrix} \succ 0_{M+2.} \quad (8)$$

Therefore, the nonlinear and non convex ML problem of (3) can be relaxed into an SDP optimization problem.

$$\underset{x,z,h,H}{\mathrm{minimize}} \qquad \mathrm{Trace}\left\{W\left(UHU^T - 2Uhr^T + rr^T\right)\right\}$$

Subject to $[H]_{ii} = \begin{bmatrix} y_i \\ -1 \end{bmatrix}^T \begin{bmatrix} I_2 & x \\ x^T & z \end{bmatrix} \begin{bmatrix} y_i \\ -1 \end{bmatrix}$ (9)

C. Least Square algorithm

Least Squares (LS) is usually used to minimize the estimation error. Due to lack of false information filtering ability, this scheme will cause large location error in hostile environments. The disturbance due to bearing measurement and observer position noises are unequally sized. Therefore, the performance of LS algorithm can be enhanced by defining a weighting matrix to minimization problem. The algorithm makes decision with global information; this method minimized the expected filtered mean-squared position error for a given number of active nodes by using a global knowledge of all node locations. This algorithm needs the positions of nodes and broadcasts them to all nodes and a lot of data communication; therefore Based on the algorithm, a local selection strategy is investigated. This method determines whether or not that node should be active by only incorporating geometrical knowledge of itself and the active set of nodes from the previous information. We modify the algorithm by sending the data through the energy efficiency node selection path.

6. RESULTS AND DISCUSSION

A. Location and actual estimated sensor nodes

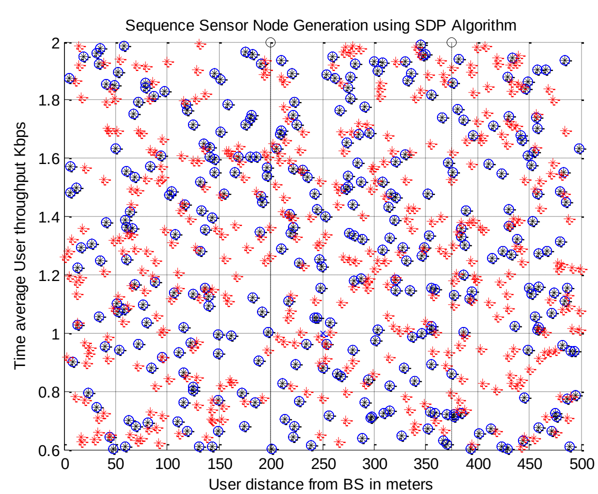

Figure 3 Sensor nodes in a network

The Figure 3 shows the actual and estimated locations of the unknown sensors represented by the red and blue symbols, respectively. Here, the throughput was about 2Kbps for SDP algorithm. Since, number of sensors are kept unchanged, the density of the sensors decreased as we increased the area. Simulation experiments show that the RMS error in terms of distance is increased with decreasing the sensor density.

B. Position of sensor nodes in heterogeneous wireless system

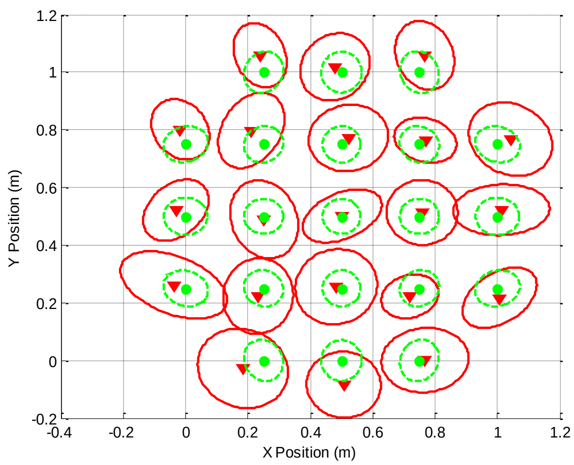

Figure 4 Position of sensor nodes in Heterogeneous wireless system

Figure 4 indicates Heterogeneous wireless sensor network (heterogeneous WSN) consists of sensor nodes with different ability, such as different computing power and sensing range. Compared with homogeneous WSN, deployment and topology control are more complex in heterogeneous WSN. In this paper, a deployment and topology control method is presented for heterogeneous sensor nodes with different communication and sensing range.

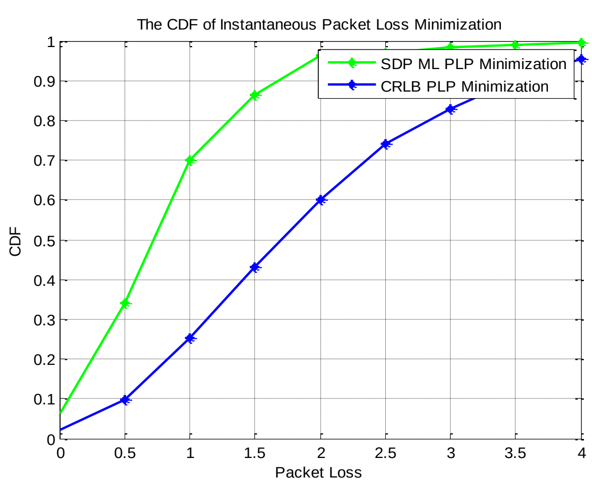

Figure 5 Packet Loss estimation

C. Packet loss estimation using CRLB and SDP algorithms

From figure 5, according to the decisions of the new proposed handover algorithm the packet loss calculated.

The packet loss is estimated using Cumulative Distribution Function (CDF). The cumulative distribution function is one of the most regularly used parameters, which is used to measure the efficiency of any packet loss.

D. Packet loss reduction using CRLB, SDP and SDP ML algorithms

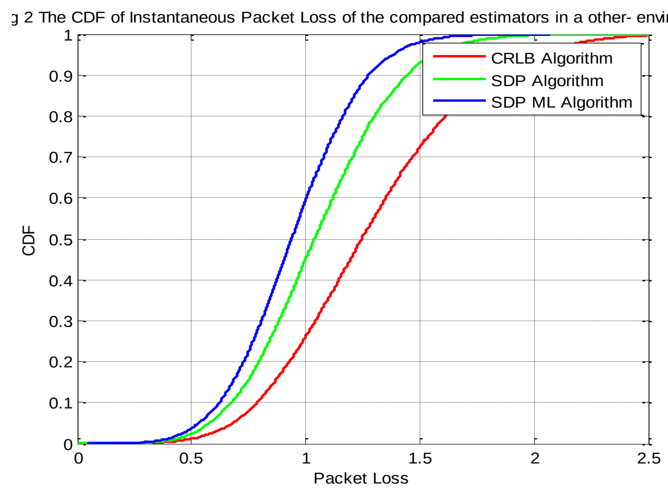

Figure 6 Packet loss reduction using CRLB, SDP and SDP ML algorithms

Figure 6 describes the estimated packet loss is reduced into 2.5 decibels. The SDP ML algorithm provides more accurate result than CRLB and SDP. We present two new methods that utilize semi-definite programming (SDP) relaxation for direct source localization. We further address the issue of robust estimation given measurement errors and inaccuracy in the locations of receiving sensors. Our results demonstrate some potential advantages of source localization based on the direct TOA data over time-difference pre processing.

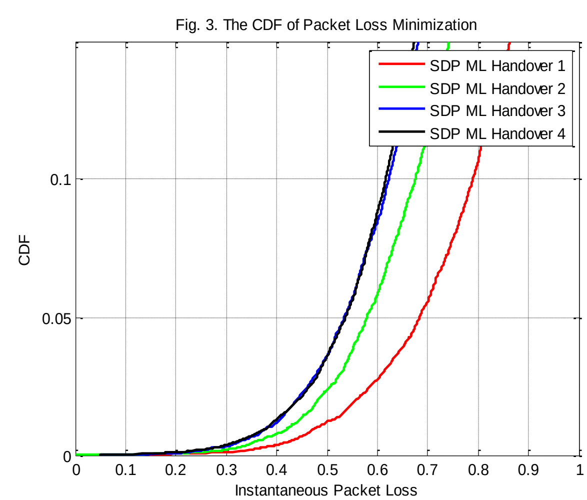

Figure 7 Instantaneous packet loss reduction

E. Instantaneous packet loss reduction

Figure 7 shows the instantaneous packet loss reduced to 1db.When the handover of heterogeneous network increases the packet loss reduces.

F. Channel estimation using SDP and CRLB algorithms

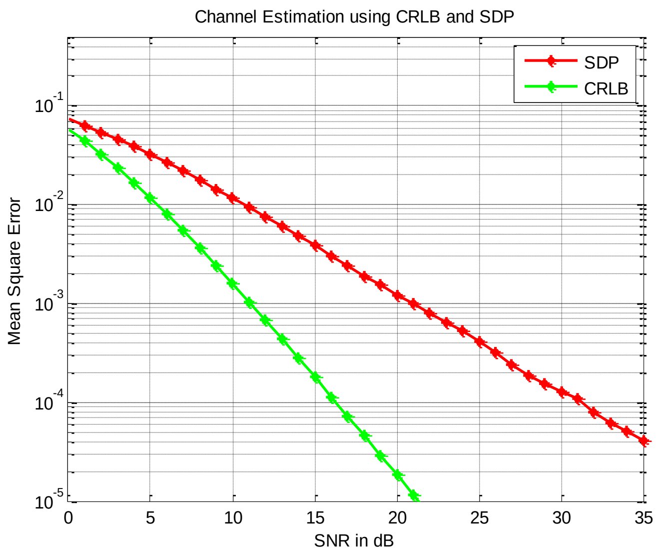

Figure 8 Channel estimation using SDP and CRLB algorithms

Figure 8 shows the channel estimation between SNR and Mean Square error is higher for SDP than the CRLB algorithm. When the Error reduced the SNR is increased more than 35 dB.

7. CONCLUSION

Wireless sensor network localization has attracted significant research interest. This interest is expected to grow further with the proliferation of wireless sensor network applications. This paper has provided a review of the measurement techniques in WSN localization and the corresponding localization algorithms. In order to demonstrate the necessity of such analysis, the superiority of a PLR-based algorithm is also demonstrated by comparison to one based on the received signal strength, specifically the RSSI. Also CRLB and SDP algorithms were implemented in order to estimate the TDOA and TOA. Our research showed that there were significant differences in the obtained precession and availability of the location estimates comparing various algorithms. The performance of the algorithms depends on the network topology and the position of the target node.

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